

**THE STATE OF TEXAS**

It is mutually understood and agreed by and between the undersigned contracting parties of the above numbered Contract to amend said contract as follows:

**In addition, the contract is extended two years for a new termination date of December 31, 2013.**

**For a total contract amount not to exceed \$260,000 (two hundred twenty thousand dollars)**

RECEIVING AGENCY

PERFORMING PARTY

**TEXAS PARKS AND WILDLIFE DEPARTMENT**

**TEXAS STATE UNIVERSITY**

By:

Tammy Dunham, CTPM CTCM  
Contract Specialist

By

12/2/11

Date \_\_\_\_\_

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## Attachment A

**Project Title:** Application of Unmanned Aerial Vehicle Imagery in Support of TPWD Conservation Goals: Phase II

**Need:** To explore potential applications of UAV technology in support of fish and wildlife conservation goals, TPWD convened a workshop in summer 2010 with UAV experts from Utah State University (USU) and Texas State University (TxState). Specific goals of the workshop were to develop a prioritized list of potential TPWD UAV applications to be evaluated through a research collaboration with USU and TxState, and to develop a UAV Applications Workgroup to (1) coordinate TPWD involvement in current and future collaborative research with TxState and USU surrounding uses and applications of the UAV technology, and (2) transition the results of this research to inform program decisions on application of the UAV in support of TPWD resource assessment and monitoring programs.

The prioritized list of potential research applications developed at the TPWD UAV Applications Workshop was refined to three high-priority focus areas outlined below.

- (1) Ability to use imagery collected by the UAV to identify and enumerate various terrestrial wildlife species (e.g., waterbird rookery counts, waterfowl, pronghorn), including ability to characterize age and sex of individuals.
- (2) Ability to characterize native and invasive vegetative communities (i.e., species classification, ~~patch delineation, coverage, succession~~) for habitat management, restoration, and post-disturbance recovery (e.g., oil and gas development, fire, flooding) in freshwater, marine (e.g., seagrasses) and terrestrial systems.
- (3) Ability to quantify pressures from human use of areas with sensitive habitats and species.

**Objective:** Objectives of this project are to evaluate the efficacy of the UAV system to acquire imagery and develop standardized image classification and processing protocols that can be applied by TPWD staff to monitor and assess fish, wildlife and their habitats.

### Approach:

- (1) Project Planning - In collaboration with TxState, TPWD will develop specific target areas, focal species, aerial extent, time windows, image resolution, ground truth data needs and related technical objectives within each of the three focus areas identified above. This will include the identification of specific desired image processing outcomes for each research area. From this work, TxState will develop algorithms and data processing techniques that support automated classification and identification of at least three TXWAP Species of Greatest Conservation Need and the habitats they utilize. This will allow for the automated processing of other remote sensing datasets targeting these species (collected by UAV, satellite and other remote sensing platforms), supporting population and habitat surveys needed to develop project-scale conservation action plans within a landscape context.
- (2) UAV Deployment - Geo-referenced, aerial photographs will be collected by TxState in target areas using the AggieAir Flying Circus ([www.aggieair.usu.edu](http://www.aggieair.usu.edu)). This UAV system provides high resolution, multi-spectral aerial imagery using a small, unmanned, remote-controlled aircraft. The system is an easy-to-use platform that it is able to map areas quicker, more frequently, at greater resolution, and at a lower cost than conventional remote sensing platforms. Furthermore, it is independent of a runway, which gives the user the ability to launch the aircraft from virtually anywhere. There will be habitat inventories completed in targeted areas (within the native range of SGCN) that support conservation of at least three SGCN.
- (3) Image Processing and Classification - Based on previous image classification experience and available ground truth data collected at the time of image acquisition, a step-wise analytical approach

will be undertaken by TxState as follows. For each target feature, an unsupervised classification approach will be undertaken and results compared to the ground truth data to develop an error assessment matrix. These results will be used in an iterative procedure by varying analytical parameters until the minimum error matrix is achieved. The second step will utilize one-half of the ground truth data to undertake an iterative supervised signature extraction step where the maximum separability of target classes is achieved. These training classes will then be applied to the second half of the ground truth data and the corresponding error matrix computed. If a given target image class(es) have an unacceptable high classification error, then alternative custom algorithm approaches (e.g., statistical learning machine, state vector machine) will be considered and discussed with TPWD. In those cases where a custom classification approach is undertaken, the underlying algorithm and model parameters will be documented and delivered as an add-in to the ERDAS IMAGINE software system used for image classification. Population surveys will be completed for at least three SGCN using image rectification and classification techniques developed through this project.

**Expected Results and Benefits:** Many different Species of Greatest Conservation Need, and their habitats, will benefit from the data collected by using this UAV technology. In this project, the focus will be mainly on aquatic species and their habitats found in the Texas Conservation Action Plan (TCAP). Specific habitats and meso-habitats, and species that will be studied, have not yet been determined and will be dependent on appropriate air-space access to targeted areas of highest concern. Such possibilities identified include: unique riparian habitats, spring systems, wetlands and playa lakes, estuaries, and unique riverine systems which will typically also support, sometimes endemic, species identified in the TCAP. Along with the collection of newer data, technicians will analyze and model newer data with older iterations of imagery to determine a best fit model for SGCN and their habitats as well as developing protocols for TPWD to use this technology in the future. The following general benefits will result from the identified approaches and be provided as deliverables to TPWD by TxState at the completion of this project:

- (1) A critical evaluation of the utility of existing UAV platforms to acquire remotely sensed data across three broad areas of fish and wildlife conservation.
- (2) Development of image acquisition and processing protocols necessary for implementation of the UAV platform as an alternative approach for TPWD fish and wildlife assessment and monitoring programs.
- (3) Quantitative evaluation of the UAV platform to meet TPWD program needs.

The results of this project will be developed into three to four manuscripts for publication in ecological, conservation, and remote sensing journals.

**Planned Budget:**

TPWD Share (Provided through State Wildlife Grant Program; 65%)	\$169,000.00
TxState Cost-Share (35%)	\$91,000.00
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	Total \$260,000.00